1
00:01:44,960 --> 00:01:42,120
success in flight did not come without

2
00:01:47,250 --> 00:01:44,970
failure during the past century

3
00:01:49,710 --> 00:01:47,260
explorers from Earth have failed many

4
00:01:51,240 --> 00:01:49,720
times to escape from their planet where

5
00:01:54,570 --> 00:01:51,250
they have been imprisoned by the chains

6
00:01:56,370 --> 00:01:54,580
of gravity since the dawn of time but

7
00:01:59,360 --> 00:01:56,380
with each failure came new knowledge

8
00:02:02,010 --> 00:01:59,370
with over the years led to success

9
00:02:04,350 --> 00:02:02,020
enabling space pioneers to build a

10
00:02:21,070 --> 00:02:04,360
celestial highway to take them on

11
00:02:25,800 --> 00:02:23,380
in the world of spaceflight hardware

12
00:02:29,170 --> 00:02:25,810
success requires reliable design

13
00:02:30,760 --> 00:02:29,180

manufacturing and testing after being

14
00:02:33,250 --> 00:02:30,770
manufactured and assembled with

15
00:02:35,260 --> 00:02:33,260
precision spacecraft are tested in a

16
00:02:37,030 --> 00:02:35,270
laboratory to determine if they can

17
00:02:39,430 --> 00:02:37,040
survive the rigorous launching into

18
00:02:42,760 --> 00:02:39,440
orbit and other hostilities of the space

19
00:02:45,010 --> 00:02:42,770
environment the idea of testing a

20
00:02:46,960 --> 00:02:45,020
machine before flying it began long

21
00:02:49,870 --> 00:02:46,970
before rocket flights commenced in the

22
00:02:52,540 --> 00:02:49,880
1940s the Wright brothers built their on

23
00:02:56,110 --> 00:02:52,550
win time and tested a variety of wind

24
00:02:58,090 --> 00:02:56,120
shapes they also flew more than 1000

25
00:03:01,750 --> 00:02:58,100
flights at Kitty Hawk with a powerless

26
00:03:05,350 --> 00:03:01,760
glider during 1902 one year before their

27
00:03:08,200 --> 00:03:05,360
historical powered flight Wilbur Wright

28
00:03:10,600 --> 00:03:08,210
to allay parental fears about the 1903

29
00:03:13,240 --> 00:03:10,610
flight wrote a letter to his father in

30
00:03:15,070 --> 00:03:13,250
which he said the man who wishes to keep

31
00:03:18,100 --> 00:03:15,080
it the problem long enough to really

32
00:03:20,880 --> 00:03:18,110
learn anything positively must not take

33
00:03:23,080 --> 00:03:20,890
dangerous risks carelessness and

34
00:03:25,690 --> 00:03:23,090
overconfidence are usually more

35
00:03:30,940 --> 00:03:25,700
dangerous than deliberately accepted

36
00:03:32,620 --> 00:03:30,950
risks Wilbur Wright concluded the Wright

37
00:03:34,960 --> 00:03:32,630
brothers understood that flying was

38
00:03:39,280 --> 00:03:34,970

risky but felt the dangers could be

39
00:03:41,320 --> 00:03:39,290
understood controlled and accepted the

40
00:03:43,960 --> 00:03:41,330
tradition of flight testing begun by the

41
00:03:46,479 --> 00:03:43,970
Wright brothers is continued today in a

42
00:03:47,949 --> 00:03:46,489
broadly expanded way and one of the

43
00:03:50,560 --> 00:03:47,959
world's leading space science

44
00:03:54,120 --> 00:03:50,570
laboratories NASA's Goddard Space Flight

45
00:03:56,260 --> 00:03:54,130
Center just outside of Washington DC

46
00:03:58,030 --> 00:03:56,270
Goddard is among the world's leading

47
00:04:01,000 --> 00:03:58,040
pioneers in developing the technology

48
00:04:03,430 --> 00:04:01,010
for building and environmentally testing

49
00:04:07,420 --> 00:04:03,440
scientific instruments spacecraft and

50
00:04:13,309 --> 00:04:10,039
Godard has the in-house capability to

51
00:04:15,589 --> 00:04:13,319
conceive design manufacture test and

52
00:04:18,289 --> 00:04:15,599
deliver scientific instruments and

53
00:04:21,099 --> 00:04:18,299
complete Space Systems to investigate

54
00:04:23,650 --> 00:04:21,109
the physical universe in which we live

55
00:04:26,090 --> 00:04:23,660
Goddard's overall capability to support

56
00:04:28,460 --> 00:04:26,100
wide-ranging scientific investigations

57
00:04:32,719 --> 00:04:28,470
makes it one of the most unique space

58
00:04:34,730 --> 00:04:32,729
science laboratories in the world during

59
00:04:36,770 --> 00:04:34,740
the 25 years that Goddard hardware

60
00:04:39,290 --> 00:04:36,780
capabilities were being developed more

61
00:04:42,620 --> 00:04:39,300
than 40 complete spacecraft systems were

62
00:04:45,110 --> 00:04:42,630
integrated and tested services for

63
00:04:48,140 --> 00:04:45,120

another 2,000 sounding rocket missions

64
00:04:51,020 --> 00:04:48,150
were also provided the Goddard team

65
00:04:53,060 --> 00:04:51,030
always striving for excellence has

66
00:04:56,600 --> 00:04:53,070
established a reliability record that is

67
00:04:58,520 --> 00:04:56,610
unparalleled in space technology since

68
00:05:01,790 --> 00:04:58,530
Goddard stores opened for business in

69
00:05:04,040 --> 00:05:01,800
1960 all spacecraft or spaceflight

70
00:05:05,570 --> 00:05:04,050
systems which were built integrated and

71
00:05:10,810 --> 00:05:05,580
tested at the Goddard Space Flight

72
00:05:13,580 --> 00:05:10,820
Center have worked successfully in orbit

73
00:05:15,320 --> 00:05:13,590
the manufacturing and testing facilities

74
00:05:18,040 --> 00:05:15,330
at Goddard were designed originally for

75
00:05:20,570 --> 00:05:18,050
the small Explorer class of spacecraft

76
00:05:22,399 --> 00:05:20,580
several modifications were made over the

77
00:05:25,250 --> 00:05:22,409
years to accommodate larger spacecraft

78
00:05:27,830 --> 00:05:25,260
or space systems like the orbiting

79
00:05:30,680 --> 00:05:27,840
astronomical observatory international

80
00:05:34,510 --> 00:05:30,690
ultraviolet Explorer solar maximum

81
00:05:36,610 --> 00:05:34,520
mission and the OSS one out

82
00:05:39,040 --> 00:05:36,620
currently Goddard is integrating and

83
00:05:43,059 --> 00:05:39,050
testing the cosmic background Explorer

84
00:05:45,040 --> 00:05:43,069
or Kobe for short Kobe is the largest

85
00:05:47,680 --> 00:05:45,050
spacecraft which can be integrated and

86
00:05:49,990 --> 00:05:47,690
tested using existing Goddard facilities

87
00:05:52,089 --> 00:05:50,000
Goddard plans to expand existing

88
00:05:54,219 --> 00:05:52,099

integration and testing facilities to

89
00:05:56,559 --> 00:05:54,229
accommodate the larger spacecraft under

90
00:06:01,390 --> 00:05:56,569
development today as well as those being

91
00:06:03,790 --> 00:06:01,400
designed for the 21st century the

92
00:06:05,379 --> 00:06:03,800
complex technologies associated with the

93
00:06:07,390 --> 00:06:05,389
development of space flight systems

94
00:06:10,059 --> 00:06:07,400
require the intimate partnership of

95
00:06:12,550 --> 00:06:10,069
engineers technicians and scientists to

96
00:06:15,399 --> 00:06:12,560
accomplish rapid progress at the

97
00:06:17,920 --> 00:06:15,409
frontiers of knowledge the design

98
00:06:20,980 --> 00:06:17,930
manufacturing and environmental testing

99
00:06:23,290 --> 00:06:20,990
teams atwater work in harmony like the

100
00:06:25,360 --> 00:06:23,300
members of a symphony orchestra to

101
00:06:28,050 --> 00:06:25,370
produce a result far beyond the

102
00:06:30,610 --> 00:06:28,060
capability of any single individual the

103
00:06:32,950 --> 00:06:30,620
Goddard facilities are instruments in

104
00:06:35,379 --> 00:06:32,960
the hands of professionals who operate

105
00:06:39,490 --> 00:06:35,389
them and are among the best in the

106
00:06:41,290 --> 00:06:39,500
aerospace community Goddard maintains a

107
00:06:42,969 --> 00:06:41,300
complete manufacturing facility

108
00:06:45,999 --> 00:06:42,979
including computer-aided manufacturing

109
00:06:47,500 --> 00:06:46,009
equipment and traditional manually

110
00:06:49,720 --> 00:06:47,510
operated machine

111
00:06:52,100 --> 00:06:49,730
by using computer-aided manufacturing

112
00:06:54,920 --> 00:06:52,110
techniques spaceflight hardware

113
00:06:58,310 --> 00:06:54,930

components can be machined using precise

114
00:07:00,440 --> 00:06:58,320
computer-controlled equipment computer

115
00:07:03,170 --> 00:07:00,450
aided manufacturing allows complex

116
00:07:05,180 --> 00:07:03,180
machine tasks to be performed including

117
00:07:07,820 --> 00:07:05,190
geometrical configurations with

118
00:07:09,770 --> 00:07:07,830
intersections of curves and angles that

119
00:07:15,680 --> 00:07:09,780
cannot be machined using traditional

120
00:07:17,240 --> 00:07:15,690
methods spacecraft and instrument

121
00:07:20,300 --> 00:07:17,250
components are electro chemically

122
00:07:22,340 --> 00:07:20,310
processed to guard against oxidation and

123
00:07:25,000 --> 00:07:22,350
to provide for thermal and electrical

124
00:07:27,160 --> 00:07:25,010
conductivity and electrical resistance a

125
00:07:29,210 --> 00:07:27,170
wide range of electroplating

126
00:07:32,840 --> 00:07:29,220
capabilities is available including

127
00:07:36,700 --> 00:07:32,850
nickel black nickel copper gold irrigate

128
00:07:39,350 --> 00:07:36,710
anodized silver and electro polishing

129
00:07:41,810 --> 00:07:39,360
for spacecraft thermal purposes

130
00:07:44,090 --> 00:07:41,820
inorganic tanks and are not commercially

131
00:07:47,120 --> 00:07:44,100
available are formulated and applied to

132
00:07:49,010 --> 00:07:47,130
flight hardware composite coatings and

133
00:07:50,750 --> 00:07:49,020
techniques are developed for the vacuum

134
00:07:54,290 --> 00:07:50,760
deposition of metals on spacecraft

135
00:07:56,270 --> 00:07:54,300
surfaces and experiments all the

136
00:07:58,400 --> 00:07:56,280
protective risers for the astronauts

137
00:08:02,420 --> 00:07:58,410
helmets are vacuum coated at dhadak

138
00:08:04,790 --> 00:08:02,430

using a unique process plastic and

139
00:08:06,830 --> 00:08:04,800
elastomer technology and fabrication

140
00:08:09,200 --> 00:08:06,840
services for constructing and assembling

141
00:08:11,990 --> 00:08:09,210
spacecraft and experimental components

142
00:08:14,420 --> 00:08:12,000
are available the ultraviolet

143
00:08:16,070 --> 00:08:14,430
transmitting plexiglass light pipes for

144
00:08:18,380 --> 00:08:16,080
the energetic gamma ray experiment

145
00:08:20,660 --> 00:08:18,390
telescope which will fly on the gamma

146
00:08:25,940 --> 00:08:20,670
ray Observatory were manufactured at

147
00:08:27,740 --> 00:08:25,950
Goddard Space Systems manufactured by

148
00:08:30,260 --> 00:08:27,750
Goddard are qualified through a rigorous

149
00:08:33,050 --> 00:08:30,270
verification program to assure flight

150
00:08:35,630 --> 00:08:33,060
readiness components are subjected to a

151
00:08:38,360 --> 00:08:35,640
wide range of tests and environmental

152
00:08:40,910 --> 00:08:38,370
exposures that simulate peak loads to be

153
00:08:43,220 --> 00:08:40,920
encountered during their lifetime after

154
00:08:45,590 --> 00:08:43,230
a spacecraft has been fully integrated

155
00:08:47,570 --> 00:08:45,600
the system is tested to make sure it

156
00:08:50,750 --> 00:08:47,580
works under anticipated flight and

157
00:08:52,640 --> 00:08:50,760
orbital conditions Goddard environmental

158
00:08:55,310 --> 00:08:52,650
testing capabilities are broadly divided

159
00:08:57,650 --> 00:08:55,320
into structural testing magnetic and

160
00:09:01,370 --> 00:08:57,660
electromagnetic measurements and space

161
00:09:03,920 --> 00:09:01,380
simulation structural testing includes

162
00:09:10,820 --> 00:09:03,930
all phases of static and dynamic testing

163
00:09:14,210 --> 00:09:10,830

covering vibration shock and orbit

164
00:09:16,430 --> 00:09:14,220
retrieval and landing these tests are

165
00:09:19,549 --> 00:09:16,440
conducted developing the integrity of

166
00:09:24,629 --> 00:09:22,170
static load testing provides a solution

167
00:09:26,879 --> 00:09:24,639
to the increasing need for step stress

168
00:09:30,389 --> 00:09:26,889
testing of structure using hydraulic

169
00:09:32,549 --> 00:09:30,399
loading systems acceleration testing

170
00:09:35,369 --> 00:09:32,559
instructors is an alternative to static

171
00:09:37,590 --> 00:09:35,379
load testing the launch base simulator

172
00:09:40,079 --> 00:09:37,600
is a high-capacity centric view and

173
00:09:44,579 --> 00:09:40,089
imposes loads on a structure typical of

174
00:09:45,059 --> 00:09:44,589
actual fight acceleration rod launch

175
00:09:47,400 --> 00:09:45,069
phase

176
00:09:49,980 --> 00:09:47,410
similarly can exert acceleration forces

177
00:09:55,170 --> 00:09:49,990
up to 30 G's on space structures

178
00:09:57,629 --> 00:09:55,180
weighing up to 5,000 pounds a dynamic

179
00:09:59,639 --> 00:09:57,639
test called mobile survey is also

180
00:10:02,639 --> 00:09:59,649
conducted the major the response of

181
00:10:04,829 --> 00:10:02,649
structures to vibratory load the modal

182
00:10:07,470 --> 00:10:04,839
server allows for a direct comparison

183
00:10:11,460 --> 00:10:07,480
with actual mobile parameters with the

184
00:10:13,769 --> 00:10:11,470
mathematical model migration exciters

185
00:10:16,319 --> 00:10:13,779
which generate a range of sine and

186
00:10:18,660 --> 00:10:16,329
random forces over a frequency range of

187
00:10:21,059 --> 00:10:18,670
five to two thousand Hertz and in

188
00:10:24,299 --> 00:10:21,069

whether than 30 pounds to 35 thousand

189
00:10:26,549 --> 00:10:24,309
pounds are they these exciter systems

190
00:10:28,739 --> 00:10:26,559
similarly the types of vibration space

191
00:10:31,319 --> 00:10:28,749
Hardware experience during launching and

192
00:10:33,900 --> 00:10:31,329
again during re-entry aboard the space

193
00:10:35,850 --> 00:10:33,910
shuttle to simulate the noise

194
00:10:37,559 --> 00:10:35,860
environment during launching space

195
00:10:39,929 --> 00:10:37,569
flight components are tested in an

196
00:10:42,600 --> 00:10:39,939
acoustic facility which consists of a

197
00:10:44,560 --> 00:10:42,610
reverberation chamber acoustic horns and

198
00:10:47,620 --> 00:10:44,570
noise generators

199
00:10:49,420 --> 00:10:47,630
noise levels up to 150 decibels which

200
00:10:51,700 --> 00:10:49,430
would see the shuttle environment level

201
00:10:55,170 --> 00:10:51,710
inside the shuttle payload Bay can be

202
00:10:57,550 --> 00:10:55,180
generated in the acoustic facility after

203
00:10:59,980 --> 00:10:57,560
structural loads testing is completed

204
00:11:02,890 --> 00:10:59,990
the spacecraft is subjected to ultrafine

205
00:11:05,320 --> 00:11:02,900
vacuum and chemical cleaning before it

206
00:11:11,020 --> 00:11:05,330
enters the plenum to begin electronic

207
00:11:12,550 --> 00:11:11,030
assembly and intubation cleanroom

208
00:11:15,040 --> 00:11:12,560
standards at Goddard are among the

209
00:11:17,500 --> 00:11:15,050
strictest in the aerospace industry the

210
00:11:20,170 --> 00:11:17,510
particles such as dust or human dandruff

211
00:11:22,390 --> 00:11:20,180
or contaminants such as grease or other

212
00:11:24,910 --> 00:11:22,400
hydrocarbons migrate to sensitive

213
00:11:27,850 --> 00:11:24,920

surfaces that could degrade components

214
00:11:29,770 --> 00:11:27,860
or balance contaminants can compromise

215
00:11:32,710 --> 00:11:29,780
the objective of a scientific instrument

216
00:11:35,980 --> 00:11:32,720
or can be the direct cause of a total

217
00:11:38,170 --> 00:11:35,990
spacecraft failure Goddard operates a

218
00:11:40,720 --> 00:11:38,180
main cleanroom for spacecraft assembly

219
00:11:43,450 --> 00:11:40,730
and several clean tents for the Assembly

220
00:11:45,490 --> 00:11:43,460
of subsystems and instruments the

221
00:11:47,740 --> 00:11:45,500
Goddard contamination control system

222
00:11:51,130 --> 00:11:47,750
filters the air to prevent particles of

223
00:11:53,680 --> 00:11:51,140
a size larger than one 300 the diameter

224
00:11:58,240 --> 00:11:53,690
of a single human hair from entering the

225
00:12:00,580 --> 00:11:58,250
cleanroom spacecraft and flight

226
00:12:03,220 --> 00:12:00,590
components also undergo magnetic and

227
00:12:05,350 --> 00:12:03,230
electromagnetic measurements and the

228
00:12:07,420 --> 00:12:05,360
magnetic test facility technicians

229
00:12:09,100 --> 00:12:07,430
perform simulations of the magnetic

230
00:12:11,829 --> 00:12:09,110
field environment of near

231
00:12:14,490 --> 00:12:11,839
torment or planetary space for

232
00:12:17,170 --> 00:12:14,500
calibrating instruments and spacecraft

233
00:12:19,600 --> 00:12:17,180
the magnetic test facility totally

234
00:12:21,670 --> 00:12:19,610
constructed from non-magnetic materials

235
00:12:24,130 --> 00:12:21,680
is the only one of its kind in the

236
00:12:27,160 --> 00:12:24,140
United States making it a national

237
00:12:28,750 --> 00:12:27,170
resource the Department of Defense and

238
00:12:31,150 --> 00:12:28,760

several other government agencies as

239
00:12:36,130 --> 00:12:31,160
well as private companies use the

240
00:12:38,410 --> 00:12:36,140
facility shielded rooms are available

241
00:12:40,600 --> 00:12:38,420
for electromagnetic interference and

242
00:12:43,630 --> 00:12:40,610
compatibility testing of flight hardware

243
00:12:45,610 --> 00:12:43,640
in a clean environment the frequency and

244
00:12:47,769 --> 00:12:45,620
amplitude of intentionally generated

245
00:12:50,110 --> 00:12:47,779
signals as well as spurious signals

246
00:12:52,710 --> 00:12:50,120
produced by the hardware are measured in

247
00:12:54,850 --> 00:12:52,720
the electromagnetic test facility

248
00:12:57,160 --> 00:12:54,860
electromagnetic compatibility Commerce

249
00:12:59,530 --> 00:12:57,170
which could interfere with spacecraft or

250
00:13:03,970 --> 00:12:59,540
instrument operation are detected and

251
00:13:05,610 --> 00:13:03,980
corrected spacecraft undergo their final

252
00:13:08,710 --> 00:13:05,620
tests in the space environment

253
00:13:10,600 --> 00:13:08,720
simulating although each of the many

254
00:13:13,090 --> 00:13:10,610
working parts of a spacecraft have been

255
00:13:15,130 --> 00:13:13,100
tested earlier at low levels higher than

256
00:13:17,590 --> 00:13:15,140
those expected for their space mission

257
00:13:20,410 --> 00:13:17,600
they are now asked to work again at

258
00:13:21,720 --> 00:13:20,420
expected loans as one single spacecraft

259
00:13:24,150 --> 00:13:21,730
system

260
00:13:26,129 --> 00:13:24,160
under vacuum conditions spacecraft

261
00:13:28,530 --> 00:13:26,139
experience a wide range of thermal

262
00:13:30,900 --> 00:13:28,540
conditions from a minus 300 degrees

263
00:13:34,620 --> 00:13:30,910

Fahrenheit to plus 200 degrees

264
00:13:36,900 --> 00:13:34,630
Fahrenheit during the entire thermal

265
00:13:39,210 --> 00:13:36,910
vacuum testing period spacecraft are

266
00:13:41,129 --> 00:13:39,220
operated at extreme and normal

267
00:13:43,920 --> 00:13:41,139
temperature just as if they were in

268
00:13:46,829 --> 00:13:43,930
orbit Goddard has several thermal vacuum

269
00:13:52,769 --> 00:13:46,839
chambers of various sizes up to 30 feet

270
00:13:54,840 --> 00:13:52,779
in diameter by 40 feet high Goddard's

271
00:13:56,939 --> 00:13:54,850
history in developing space systems for

272
00:13:59,850 --> 00:13:56,949
orbital flight has been long and

273
00:14:02,009 --> 00:13:59,860
distinguished Goddard is the only NASA

274
00:14:04,170 --> 00:14:02,019
federal government field center with an

275
00:14:05,730 --> 00:14:04,180
in-house capability of taking space

276
00:14:09,870 --> 00:14:05,740
hardware from design through

277
00:14:11,730 --> 00:14:09,880
manufacturing and testing with an eye

278
00:14:13,949 --> 00:14:11,740
toward the future Goddard has been

279
00:14:15,870 --> 00:14:13,959
assigned a major role for servicing

280
00:14:18,900 --> 00:14:15,880
spacecraft systems under development

281
00:14:22,889 --> 00:14:18,910
such as the Hubble Space Telescope grow

282
00:14:23,900 --> 00:14:22,899
new ARS and future spacecraft such as

283
00:14:26,639 --> 00:14:23,910
access

284
00:14:28,800 --> 00:14:26,649
guards parking space craft servicing

285
00:14:31,350 --> 00:14:28,810
on-orbit is an outgrowth of the Center's

286
00:14:35,160 --> 00:14:31,360
success in the pioneering solar max

287
00:14:37,470 --> 00:14:35,170
repair mission to accommodate future

288
00:14:39,930 --> 00:14:37,480

spacecraft systems such as the Explorer

289
00:14:41,970 --> 00:14:39,940
series as well as the co-orbiting and

290
00:14:44,160 --> 00:14:41,980
polar platforms for Space Station

291
00:14:47,850 --> 00:14:44,170
Goddard is planning to expand existing

292
00:14:49,829 --> 00:14:47,860
integration and testing facilities for

293
00:14:52,110 --> 00:14:49,839
this next generation of spacecraft for

294
00:14:53,970 --> 00:14:52,120
work operations will be demonstrated

295
00:14:56,250 --> 00:14:53,980
first on the ground in a clean

296
00:14:58,280 --> 00:14:56,260
laboratory environment to protect the

297
00:15:00,750 --> 00:14:58,290
flight hardware from contamination

298
00:15:03,329 --> 00:15:00,760
facilities which provide a contamination

299
00:15:05,340 --> 00:15:03,339
free environment are essential to the

300
00:15:12,010 --> 00:15:05,350
reliable performance of the large

301
00:15:16,790 --> 00:15:14,630
the Goddard Space Flight Center stands

302
00:15:21,230 --> 00:15:16,800
ready to take the next major step in

303
00:15:23,510 --> 00:15:21,240
space research in 1984 President Reagan

304
00:15:24,910 --> 00:15:23,520
permitted the United States to having a

305
00:15:28,310 --> 00:15:24,920
permanently manned space station

306
00:15:30,550 --> 00:15:28,320
operating within a decade the president

307
00:15:34,750 --> 00:15:30,560
said that a space station was needed for

308
00:15:37,760 --> 00:15:34,760
peaceful economic and scientific game

309
00:15:41,510 --> 00:15:37,770
space station is NASA's next logical

310
00:15:43,940 --> 00:15:41,520
step in America's space program Goddard

311
00:15:46,550 --> 00:15:43,950
is planning facilities to support NASA's

312
00:15:49,520 --> 00:15:46,560
space science program in the 1990s and

313
00:15:50,330 --> 00:15:49,530

space exploration well into the 21st

314
00:15:52,850 --> 00:15:50,340
century

315
00:15:56,180 --> 00:15:52,860
when pioneering men and women from many